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ABSTRACT

A study tested the validity of a theory of count/mass syntax in word learning. The theory proposes that children infer one of two procedures, depending on whether the referent is an object or a non-solid substance. Subjects were 36 2-year-olds, divided according to three experimental conditions. All were taught a novel word with reference to either an object or a non-solid substance, then asked to select another referent of the new word, given two choices. In the neutral syntax condition, the syntax used indicated that the new word was a noun but not whether it was a count or mass noun. In the matching syntax condition, objects were labeled with count nouns and corresponding determiners and quantifiers. In the conflicting syntax condition, mass syntax was used in object trials and count syntax was used in substance trials. Results indicate that the children were unable to use syntactic distinctions to support the two procedures for inferring meaning, contradicting the position that children learn ontological distinctions through the syntactic distinction. Further, it is concluded that some 2-year-olds do use syntax to influence their inferences about new words when the referents are non-solid substances, but not when they are solid objects. (MSE)

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SEMANTIC INFERENCES: THE ROLE OF COUNT/MASS SYNTAX

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Since the meaning of a word that has been ostensively defined is radically underdetermined by the environment, children must have constraints that guide their acquisition of word meanings (Goodman, 1983; Quine, 1969; for a few examples of constraints see Clark 1987; Hall and Waxman, in press; Markman, 1989). Soja, Carey, and Spelke (1990) have suggested that the constraints children use are sensitive to the ontological category of the referent. Specifically, they argued that the constraints depend on whether the referent is an object or a non-solid substance (e.g., mud and sand). They proposed two procedures that embody this claim:

Procedure 1 — Step 1: Test to see if the speaker could be talking about a solid object; if yes,

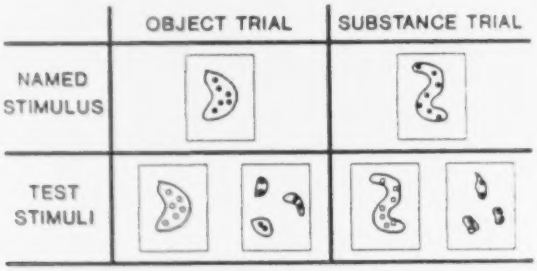
Step 2: Conclude the word refers to individual whole objects of the same type as the referent.

Procedure 2 — Step 1: Test to see if the speaker could be talking about a non-solid substance; if yes,

Step 2: Conclude the word refers to portions of substance of the same type as the referent.

Soja et al. ran two experiments which each had a condition, the neutral syntax condition, that tested these procedures. In this condition 2-year-olds were taught a new word with reference to either an object or a non-solid substance (See Figure 1). Then they were asked to select another referent of the new word given two choices. On the object trials, one choice was an object of the same kind as the original, but made out of a different material. The other choice was three small pieces of the original material. On the substance trials one choice was a new substance in the same shape as the original. The other choice was three small piles of the original substance.

Figure 1
Method in Soja, et al.



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The results of this condition support Procedures 1 and 2. On the object trials the subjects chose the object of the original object kind, ignoring the mismatch in material. In contrast, on the substance trials they chose the substance of the original substance kind, ignoring the mismatch in shape and number of piles.

This distinction in ontological kind is related to the count/mass distinction in syntax. Count nouns are quantified over individuals (e.g., "a cup" and "three cups"); mass nouns are quantified over portions (e.g., "one pile of mud" and "three piles of mud"). The count/mass distinction could interact with Procedures 1 and 2 in two different ways. First, Quine (1969) has argued that children learn to make the count/mass distinction, and through that they learn to make the ontological distinction between objects and substances.[1] Second, it could be that children use the subcategorization of a new noun, as well as Procedures 1 and 2, to determine the meaning of the word. In fact, there is evidence that young children can use the syntactic properties of new words to determine the meanings of those words in certain circumstances (Brown, 1957; Gelman and Taylor, 1984; Hall, 1990; Katz, Baker, and Macnamara, 1974; Naigles, in press).

In Soja et al. (1990), in the neutral syntax condition, the subjects' command of count/mass syntax was assessed through their spontaneous productions. There was no correlation between the subjects' control of count/mass syntax and their ability to differentiate the object trials from the substance trials even though many of the subjects had no control of count/mass syntax. These results suggest that children can use Procedures 1 and 2 even before they can use count/mass syntax.

However, the subjects' production skills may not be the best measure of their representation of count/mass syntax. Furthermore, the production result does not address the second possible role for count/mass syntax --that children use the subcategorization of a new noun as a cue to its meaning. Consequently, two different conditions were run: the matching syntax condition, which was reported in Soja et al.,[2] and the conflicting syntax condition, which is new. In the matching syntax condition the objects were labelled with count nouns and the substances were labelled with mass nouns. The syntax matched the ontological kind of the referent. Therefore, if 2-year-olds are sensitive to the relationship between count/mass syntax and the object/substance distinction, the subjects should have been even more likely to choose the object of the original object kind on the object trials and the substance of the original substance kind on the substance trials. That is, they should have differentiated the two kinds of trials even more than in the neutral syntax condition. In the

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1. Different languages may have different means of making a syntactic distinction of quantification. However, Quine must argue that people would not be able to make the object/substance distinction if their language has no syntactic devices for differentiating quantification by individuals from quantification by portions.

2. In Soja et al. the matching syntax condition was called the "informative syntax condition".

conflicting syntax condition the objects were labelled with mass nouns and the substances were labelled with count nouns. The syntax and ontology conflicted. That is, in the object trials, the ontology supported an object response, but the syntax supported a substance response. In the substance trials, the ontology supported a substance response, but the syntax supported an object response.[3] Therefore, since the cues gave conflicting information, if 2-year-olds are sensitive to the relationship between the syntax and the ontology, the subjects should have shown less of a differentiation between the two kinds of trials. Since the results of the conflicting condition have to be compared with the results of the neutral and matching conditions, those conditions will be presented here as well.[4]

The hypothesis of this research is that 2-year-olds do not use count/mass syntax to support word learning in either of the two possible ways. That is, count/mass syntax is not used as a means for acquiring Procedures 1 and 2, and count/mass syntax is not used, with Procedures 1 and 2, to constrain the meanings of new words. If this hypothesis is correct, there should be no differences between the three conditions on the object and substance trials.

Method

Subjects

There were 36 2-year-olds, ranging in age from 1;10 to 2;3 (mean age: 2;0). They were evenly divided between three groups: the neutral syntax group, the matching syntax group, and the conflicting syntax group. The first two groups had 12 girls and 12 boys each. The third group had 13 girls and 11 boys. The subjects were tested individually in their homes. The parents of each subject were paid $5.00.

Stimuli

There were four novel object kinds, with two tokens of each. The tokens were made out of different materials. The objects had the following forms: pyramids (wood and Super Sculpey[5]), pancakes (yellow wax and green plastic), kidneys (orange wax and purple plaster), and half eggs (grey styrofoam and red Super Sculpey). There were also eight novel non-solid substances, organized into four pairs: Dippity-do (a setting gel) and lumpy Nivea (a hand cream mixed with gravel); coffee (freeze dried) and orzo (a rice shaped pasta); sawdust and leather (cut into tiny pieces); and Crazy Foam and clay.

Procedure

There were four object trials and four substance trials in each condition that were repeated twice. Before and after testing the experimenter played with the subject. The entire period of involvement

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3. There are no objects in the substance trials, but the subjects could have believed that the new word referred to a certain kind of pile.

4. The neutral and matching conditions are described in more detail in Soja et al., 1990. The data from the 2-year-olds of Experiment 2 of that paper are discussed here.

5. Super Sculpey is a molding compound, similar to clay.

with the subject was tape recorded, but only the productions from the play periods were used in the analyses of linguistic competence. A syntax score was found for each subject that reflected the ability to use determiners and plural endings differentially for the two kinds of nouns.

An object trial in the neutral syntax condition. The child was presented with an object (see Figure 1). The object was given a name. For example, the experimenter said "This is my blicket". The experimenter then continued to talk about the object using "my", "the", and "this" for determiners. She and the subject manipulated the object. The object was placed to the side and two other sets of objects were presented directly in front of the subject. One set contained one object that was the same sort of object as the original but made out of a different material. The other set of objects contained 3 chunks made of the same material as the original object. They were small and in arbitrary shapes. The experimenter said, "Point to the blicket". Both objects of each type were used as the named object across subjects.

A substance trial in the neutral syntax condition. Figure 1 shows a sample substance trial. The child was shown one of the substances, being told, for example, "This is my stad". The experimenter referred to the substance using only "my", "the", and "this" for determiners. For half of the trials, the substance was presented in a single pile; for the other half in multiple small piles. The experimenter and the subject talked about the substance and played with it. In the presentation of test substances the subject was shown 2 substances, the original and the new one, and told "Point to the stad". The original substance was in the alternative configuration, while the new substance was in the configuration used originally with the named substance. Of each pair of substances one member was named and the other was used as the alternative to the original in the test presentation. Each member served in both roles across subjects.

The syntax used in the neutral condition determined that the new word was a noun, but did not indicate whether it was a count noun or a mass noun.

Object and substance trials in the matching syntax condition. The matching syntax condition differed from the neutral syntax condition only in the determiners and quantifiers used when naming the original stimulus. Objects were labelled with count nouns. For example, the experimenter said "This is a blicket". Then in subsequent discussion during the same trial the experimenter said "a blicket" and "another blicket". Substances were labelled with mass nouns. For example, the experimenter said "This is stad", "some stad", and "some more stad". These determiners were chosen because in production they are among the earliest selective determiners used by 2-year-olds (Gordon, 1982). Also, in comprehension, 3-year-olds can determine the subcategorization of a noun based on its previous occurrence with one of these determiners (Gordon, 1985). The test items were prefaced with the neutral "Which is the blicket?"

Object and substance trials in the conflicting syntax condition. The only difference between the matching syntax condition and the conflicting syntax condition was in the pairing of syntax and kind of referent. In the conflicting syntax condition mass syntax was used in the object trials and count syntax was used in the substance trials. Again, the test question always used a neutral determiner "Which is the blicket?"

Results

Word Learning Trials

The percent of trials in which each subject chose the test stimulus of the original shape was calculated for both object trials and substance trials. The mean object scores and substance scores for the subjects in each condition were: 93% and 39% in the neutral condition, 86% and 31% in the matching condition, and 77% and 56% in the conflicting condition (see Figure 2).

Figure 2

A three-way ANOVA comparing group (neutral x matching x conflicting) with trial type (object x substance) with sex was conducted. There was a significant main effect of trial type ($F(1,33) = 100.837$, $p < .001$), which demonstrates the main finding that 2-year-olds treat words that refer to objects differently than words that refer to substances. There was also a significant interaction between condition and trial type ($F(2,33) = 6.507$, $p = .004$). A Neuman-Keuls test showed that the interaction was due to the three groups being the same on the object trials but the conflicting group being different than the other two groups on the substance trials. None of the other effects were significant.

Production Data

In order to assess each child's productive command of count/mass syntax, we examined the use of selective count noun frames. Nouns that appeared in neutral syntactic frames (e.g., "the dog", "the mud", "my house", "Sandy's sand") were removed from the analysis. We then calculated for each subject the percentage of count nouns occurring in selective count noun contexts --"a (noun)", "one (noun)", "(noun)-s", "the (noun)-s", "some (noun)-s", and "two (or a higher number) (noun)-s". High scores should indicate good control of count syntax, except

for the fact that some subjects used "a" indiscriminately with count nouns and mass nouns, which yielded a high score that was misleading. To correct for such indiscriminate use, we subtracted from that score the percentage of mass nouns used in selective count noun contexts. The resultant score could be as high as 1, indicating full command of count syntax and differentiation of count and mass nouns, or as low as 0, indicating no productive control of this syntactic distinction. The scores ranged from .05 to .69 (mean .26) and 39% of the subjects scored less than .20. The three groups did not differ (neutral: .25; matching: .34; conflicting: .20; $F(2, 31) = 1.698$, $p > .2$).

We also needed a measure for each subject that reflected the child's differentiation of the object and substance trials. We subtracted the substance score from the object score for each child. Scores ranged from -12 to 100 (mean 43), with high scores reflecting good differentiation of object and substance trials. There was a significant negative correlation between the count/mass score and the object/substance score for the conflicting syntax group ($r = -.62$, $p = .03$). This indicates that the more productive control the subjects showed, the less they differentiated object trials from substance trials. Remember, in the conflicting condition, a small degree of differentiation indicates sensitivity to the syntax. There was no correlation for the other two groups (neutral syntax: .12; matching syntax: .03).

Discussion

Question 1: Do children learn to make the ontological distinction between objects and substances through the count/mass distinction?

The first step in answering this question is to examine the effect of syntax on inferences of word meaning when the syntactic information supported the ontological information. There were no differences between the neutral syntax and matching syntax conditions. These 2-year-olds were not able to use syntax to support Procedures 1 and 2. Furthermore, the children in these conditions showed no correlation between productive control of count/mass syntax and their differentiation of object and substance trials even though many of them had no productive control. This suggests that representation of count/mass syntax plays no role in the development of Procedures 1 and 2. However, it is possible that Procedures 1 and 2 are already so powerful that their effects cannot be strengthened. Although subjects could do better on the substance trials, it may be that Procedure 2 is very strong, but that another factor is inhibiting better responses (see Soja et al., 1990, for a discussion of this possibility). If so, then supportive syntax could not have an effect.

Consequently, the effect of syntax when it conflicts with ontology must be examined. There were no differences between any of the conditions on the object trials. Procedure 1 seems to be impervious to syntactic information. However, there was a difference on the substance trials. The subjects were more likely to select the substance of the

original shape when the new word was a count noun compared to either when it was a mass noun or when its subcategorization was ambiguous. To interpret this result, the individual data of the subjects in the conflicting syntax condition must be considered. The best way to evaluate which subjects were affected by the syntax is to examine the correlation between productive control of count/mass syntax and sensitivity in comprehension to count/mass syntax. The negative correlation between the subjects' production scores and their differentiation of the two kinds of trials indicates that it is just those subjects who produce count/mass syntax that are sensitive to it in comprehension. It also indicates that there are other 2-year-olds who do not represent count/mass syntax in production or comprehension, but who do represent Procedures 1 and 2. In sum, the results of the conflicting condition did unexpectedly differ from the results of the other two conditions on the substance trials. However, that difference was due to the subset of the subjects who already were producing count/mass syntax. Thus, this experiment supports the argument of Soja et al. against Quine's position that children learn the ontological distinction through the syntactic distinction.

Question 2: Are 2-year-olds able to use the subcategorization of a new noun as an indicator of the meaning of that noun?

Some, but not all, 2-year-olds do use syntax to influence their inferences about new words when the referents of the words are non-solid substances. However, they do not use syntax when the words refer to solid objects. That is, when the referent of a new word is a solid object, children use Procedure 1 and, once activated, Procedure 1 is not influenced by syntax at all. This result supports the belief that objects play an extremely important role in children's conceptual and linguistic systems (Spelke, 1985). Future research will investigate the reasons for this difference in the effects of syntax on Procedures 1 and 2.

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